

# Microhabitat sharing for basking between squamate species in Poland

Przemysław Zdunek<sup>1,2</sup>, Maksymilian Jarmoliński<sup>3</sup>

<sup>1</sup> Association du Refuge des Tortues, 2920 Route de Paulhac, 31660 Bessières, France

<sup>2</sup> NATRIX Herpetological Association, ul. Opolska 41/1, 52-010 Wrocław, Poland

<sup>3</sup> Brzezna 299, 33-386 Podegrodzie, Poland

<https://zoobank.org/4B71350B-B328-44F0-81D6-1751FC5283E3>

Corresponding author: Przemysław Zdunek ([zdunek.komodo@gmail.com](mailto:zdunek.komodo@gmail.com))

---

Academic editor: Yurii Kornilev ♦ Received 25 August 2022 ♦ Accepted 17 March 2023 ♦ Published 27 March 2023

---

## Abstract

Aggregations (e.g. group basking) by snakes are usually limited to specific life cycle phases (e.g. mating) or are a consequence of drastic environmental changes (e.g. habitat destruction), high prey densities or highly limited resources within an environment (e.g. basking sites, wintering dens). Here, we report intra- and interspecific observations of four reptile species (primarily *Natrix natrix* and *Vipera berus*) sharing basking sites at the confluence of the rivers Dunajec and Poprad near the town of Stary Sącz in southern Poland. From a total of 84 records in the field between 2020–2022, there were 11 interactions from 24 July 2020 to 1 May 2022. Previous studies have indicated direct competition or interference in many species, which we did not observe. There is a noticeable lack of such observations of microhabitat sharing for basking between squamate species in scientific literature. Hence, the accumulation of such observations has the potential to reveal new insights into the behaviour and ecology of *N. natrix* and *V. berus*.

## Key Words

adder, aggregations, *Anguis colchica*, behavioural thermoregulation, *Coronella austriaca*, ectothermy, grass snake, group behaviour, herpetofauna of Poland, reptiles

Records of a group or paired basking in snakes are infrequent; squamates usually lead a solitary life and are not sociable (Doody et al. 2021), although there are cases where they form groups in hibernacula, refugia sites or at optimal foraging locations (Costanzo 1986; Shah et al. 2006; Mebert 2011; Clark et al. 2012; Meek 2014; Christopoulos et al. 2022). These records are most often transient aggregations limited to certain life cycle phases, environmental changes and even high prey densities (Mouton 2011; Edgehouse et al. 2014; Gardner et al. 2015). In squamates, two types of aggregations are recognised: ecological (when individuals are attracted because of limited habitat availability due to external factors or too concentrated availability of resources, for example, food, shelter, basking sites) (Vasconcelos et al.

2017) and social (when individuals are attracted to conspecifics to avoid predators by group defence, increased thermoregulation (including European lizards) or mating behaviour (Graves and Duvall 1995; Kearney et al. 2001; Chapple 2003; Gardner et al. 2015; Meek and Luiselli 2022b; Turner 2022). Noteworthy and rare are observations of intra- or interspecific interactions outside the specific context that requires aggregating behaviour, often correlated with resource use, for example, heat source, mating partner, hibernacula, shelter or biotic or abiotic structures for predation avoidance (Graves and Duvall 1995; Kearney et al. 2001; Ajtić et al. 2013; Turner 2022).

Within thermoregulatory behaviour, basking in the sun is one of the most typical of thermoregulation in reptiles (Seebacher and Franklin 2005). The animals expose the



entire or at least a portion of their body to thermal radiation while being immobile (Bulté and Blouin-Demers 2010). Thus, habitat selection is a critical component of reptilian ectothermy. Various thermal qualities of microhabitats/substrates influence a reptile's choice in selecting the most favourable basking sites in order to maintain preferred body temperatures (Meek and Luiselli 2022a). A poorly-understood type of behaviour is sharing basking microhabitats between individuals, in locations where there are many favourable sites and, thus, limited pressure from the lack of potential sources.

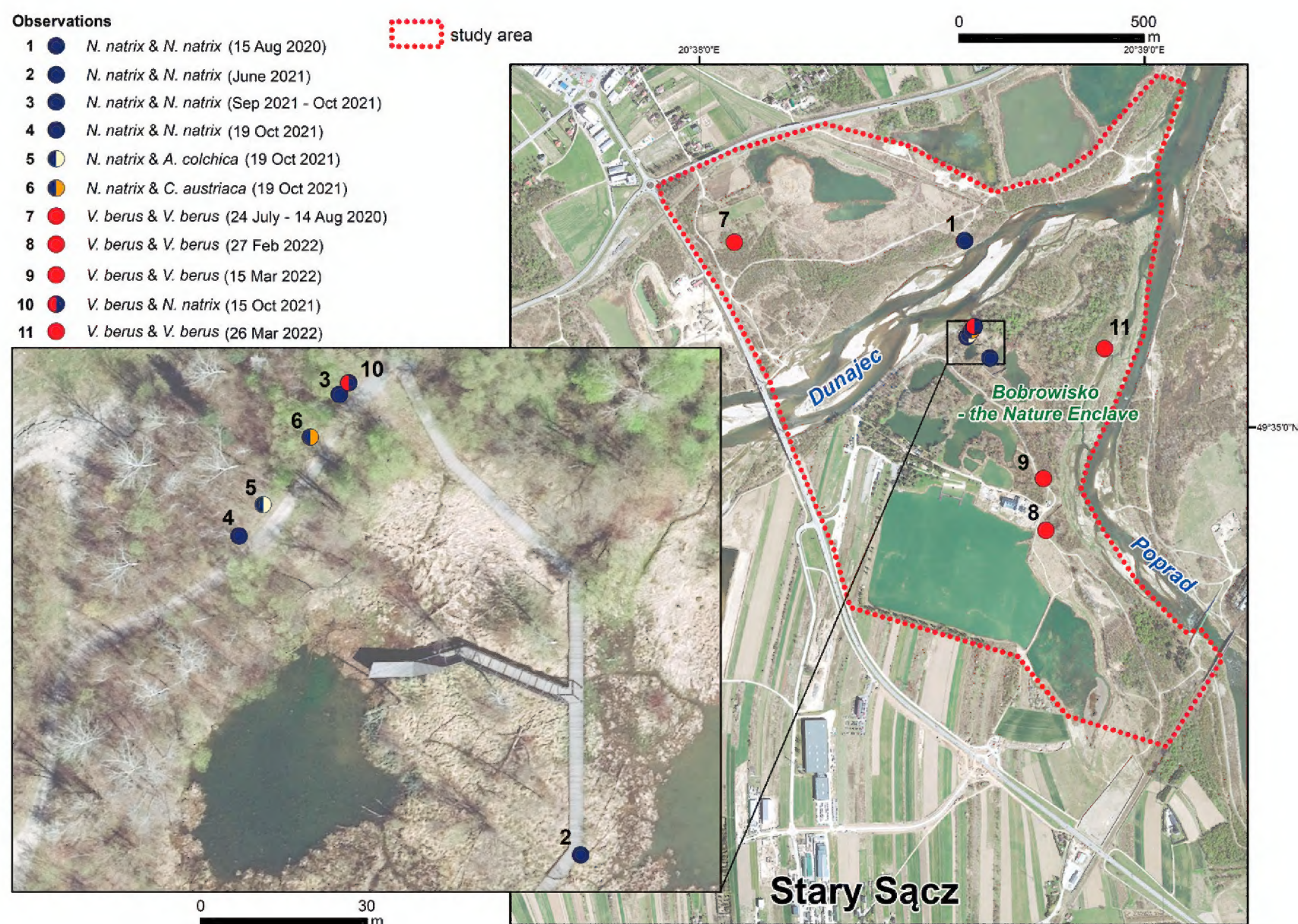
Our observations took place at the confluence of the Dunajec and Poprad rivers near the town of Stary Sącz in southern Poland (49°33'45"N, 20°38'11"E; Fig. 1), which is located south of the valley of Kotlina Sądecka. The observation area was 143 ha, including a wide variety of terrestrial and aquatic habitats suitable for the local herpetofauna. The landscape is dominated by deciduous trees (*Betula* sp., *Cornus* spp., *Populus* spp., *Salix* spp., *Quercus robur*) with a rich undergrowth (*Arrhenatherum* sp., *Dactylis glomerata*, *Salvia* spp., *Urtica dioica*) (Fig. 2). Open areas are characterised by a low percentage of shrub cover and an abundance of short herbaceous cover predominantly of *Rubus* spp. At one location (observation no. 7, Fig. 1), there were illegal landfills and trash dumping (anthropogenic refugia for snakes) covered by *Parthenocissus* sp. (Fig. 3).

As reptile predators influence the social behaviour in lizards (Chapple 2003), we recorded tentative predators; we often observed Hooded Crows (*Corvus cornix*), Common

Ravens (*Corvus corax*), Common Pheasants (*Phasianus colchicus*) and rarely the Western Marsh Harriers (*Circus aeruginosus*), Common Buzzards (*Buteo buteo*) and the Common Kestrel (*Falco tinnunculus*). We also observed Red Foxes (*Vulpes vulpes*), Northern White-breasted Hedgehogs (*Erinaceus roumanicus*) and feral cats (*Felis catus*). However, during the fieldwork, predators were never observed in the immediate vicinity of the described records.

The field surveys were performed from February to October each year. Interactions were observed in the period from 24 July 2020 to 1 May 2022 (Table 1). Fieldwork was carried out 4 to 6 times a month, approximately every 4 to 5 days, from 08:30 h to 16:00 h, by one or two researchers. We applied a Visual Encounter Survey (VES), repeated a minimum of two times per survey day (Bartman et al. 2016; Boback et al. 2020). Each animal observed was photographed if possible and only positively identified species were recorded. No animals were captured or handled. All records were made in an area seemingly providing an abundance of suitable habitats. Environmental variability (e.g. scarcity of suitable habitats) can exert substantial pressure in rapidly switching between social and solitary behaviour in squamates (Rabosky et al. 2012; Regnet et al. 2017; Vasconcelos et al. 2017). We defined grouped, or paired basking, as direct contact between individuals or a distance not greater than 50 cm between them.

Overall, we observed *Vipera berus* on 58 occasions; basking aggregations were recorded five times (in four instances with another *V. berus* and in one with *N. natrix*).

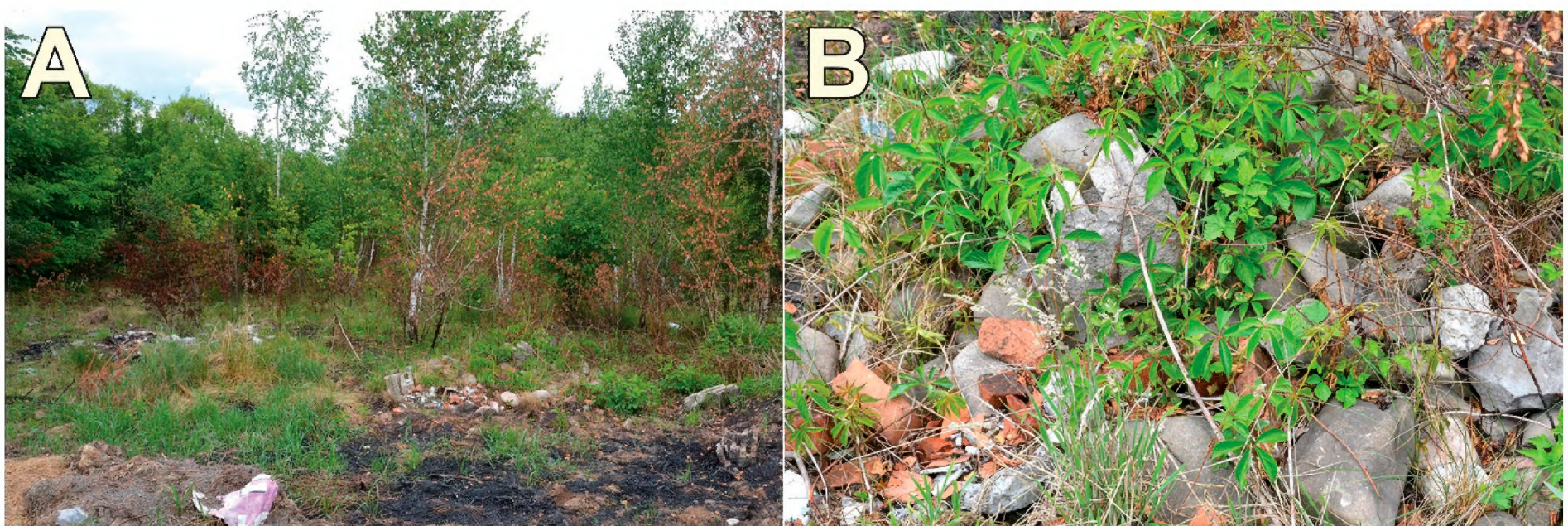


**Figure 1.** Records of microhabitat sharing during basking observed between July 2020 and March 2022 near the Dunajec and Poprad rivers confluence, Stary Sącz, Poland. Map created by Aleksandra Kolanek using base maps from <https://mapy.geoportal.gov.pl/>.





**Figure 2.** Examples of the habitats for observations no. 4, 5, 6, 3, 10 (see Fig. 1).



**Figure 3.** A pile of trash (A) and stones surrounded by grasses and thickets (B). The location is a basking site and refugia for *Vipera berus*.

For *N. natrix*, we observed communal basking on 7 out of 26 observations (four times with *N. natrix* and once each with *V. berus*, *Coronella austriaca* and *Anguis colchica*) (Table 1). In the case of adders, 8.62% share space for basking and 19.35% in the case of observed Grass Snakes.

First of our observations (and the only interaction from 2020) of *N. natrix* involving two adults basking next to each other (Fig. 4A). Subsequently, we observed snakes basking in three different locations regularly (Fig. 4B–D). *Natrix* spp. aggregates are frequently encountered during the breeding season, in limited areas and are rarely documented outside of this time period (Luiselli 1996; Meister et al. 2012; Ajtić et al. 2013).

We also observed communal basking of an adult and juvenile *N. natrix* alongside an adult Eastern Slowworm, *Anguis colchica* Nordmann, 1840 (Squamata, Anguillidae) (Fig. 5A, B) and another individual alongside an adult Smooth Snake *Coronella austriaca* Laurenti, 1768 (Squamata, Colubridae) (Fig. 5C). These were one-time observations, the snakes were no longer observed together during the survey at this site. Only solitary Smooth Snakes were regularly seen at this location (no. 6) in later observations. *Coronella austriaca* are known for feeding on snakes and legless lizards (Čeirāns and Nikolajeva 2017; Di Nicola et al. 2020; Kolanek et al. 2020), although we did not observe specific predation events.



**Table. 1.** Observations of communal basking of squamates near Stary Sącz, Poland. Observation No. corresponds to localities indicated on Fig. 1.

No.	Date	Species	Times of day	Weather	Wind	Notes/Remarks	Coordinates
1	15/08/2020	<i>N. natrix</i> & <i>N. natrix</i>	Morning	partly sunny	light	2 adults often seen in wood pile	49.588028°N, 20.643076°E
2	06/2021	<i>N. natrix</i> & <i>N. natrix</i>	Morning/ afternoon	mostly cloudy	light	2 subadults basking on a root in a swamp	49.585155°N, 20.643923°E
3	09-10/2021	<i>N. natrix</i> & <i>N. natrix</i>	Afternoon	sunny	no wind	2 individuals basking in the bushes by the path	49.585911°N, 20.643346°E
4	19/10/2021	<i>N. natrix</i> & <i>N. natrix</i>	Morning	sunny	no wind	2 adults near the path	49.585685°N, 20.643088°E
5	19/10/2021	<i>N. natrix</i> & <i>A. colchica</i>	Morning	sunny	no wind	1 Juvenile and 1 adult <i>N. natrix</i> with an adult <i>A. colchica</i>	49.585735°N, 20.643150°E
6	19/10/2021	<i>N. natrix</i> & <i>C. austriaca</i>	Morning	sunny	no wind	2 adults snakes basking at 10:00 h in the sunny clearances	49.585843°N, 20.643271°E
7	24/06-14/08/2020	<i>V. berus</i> & <i>V. berus</i>	Morning/ afternoon	sunny	no wind	3 gravid females were regularly observed in the same place	49.588111°N, 20.634451°E
8	27/02/2022	<i>V. berus</i> & <i>V. berus</i>	Afternoon	partly sunny	light	2 adults with a melanistic pattern and with a classic pattern	49.580929°N, 20.645878°E
9	15/03/2022	<i>V. berus</i> & <i>V. berus</i>	Afternoon	sunny	no wind	2 adults with a melanistic pattern	49.582192°N, 20.645833°E
10	15/10/2021	<i>V. berus</i> & <i>N. natrix</i>	Morning	sunny	light	Juvenile <i>V. berus</i> with an adult <i>N. natrix</i>	49.585930°N, 20.643370°E
11	26/03/2022	<i>V. berus</i> & <i>V. berus</i>	Morning	partly sunny	light	2 adults with a classic pattern	49.585328°N, 20.648220°E

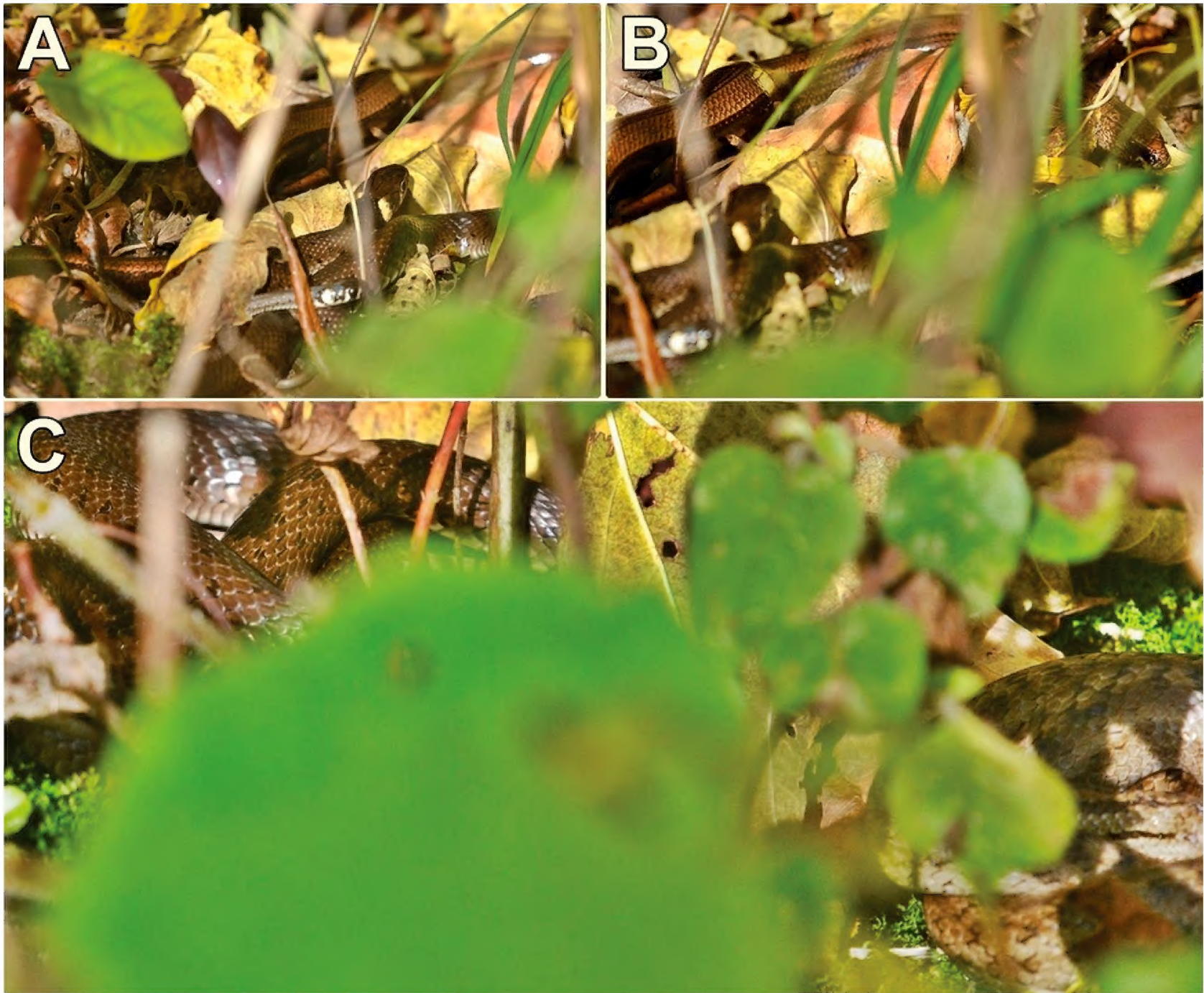


**Figure 4.** *Natrix natrix* communal basking. **A.** Observation no. 1, the same specimens were seen several times (without photographic documentation) in August 2020; **B.** Observation no. 2 in June 2021; **C.** Observation no. 3 in September/October 2021; **D.** Observation no. 4, a single record from 19 October 2021. Photographs by Maksymilian Jarmoliński.

In 2020, we observed three gravid *V. berus* Linnaeus, 1758 (Squamata, Viperidae) sharing a basking site (Fig. 6A), a behaviour also observed in *Crotalus horridus* Linnaeus, 1758 (Squamata, Viperidae) (Clark et al. 2012).

To the best of our knowledge, this behaviour has not previously been published in Polish populations of adders. Observation no. 10 was of a juvenile *V. berus* basking directly on an adult *N. natrix* (Fig. 6B). In this case, the





**Figure 5.** A, B. Two Grass Snakes (*Natrix natrix*) basking with an Eastern Slowworm (*Anguis colchica*); C. Basking *Natrix natrix* alongside a Smooth Snake (*Coronella austriaca*). Photographs by Maksymilian Jarmoliński.



**Figure 6.** A. Three gravid adders (*Vipera berus*) share a site for thermoregulation; B. Juvenile *V. berus* basking on top of a Grass Snake (*Natrix natrix*). Two adult adders with a classic (C), melanistic (D) and mixed (E) pattern thermoregulating together. Photographs by Maksymilian Jarmoliński.



direct contact between the two species was clearly visible (it was observed only on one occasion). In a separate observation (no photographic documentation was made), an adult *V. berus* was observed with a *N. natrix* at the same location (pers. obs.).

Observations 8, 9 and 11 of *V. berus* were of two adults with a classic pattern of thermoregulating and sharing a microhabitat (Fig. 6C), two melanistic adults basking together (Fig. 6D) and two snakes with a classic and a melanistic pattern after leaving the hibernaculum at the end of February 2022 (Fig. 6E). These few observations suggest that adders do not discriminate the body pattern of individuals with whom they bask. Of the 64 adders observed, 20 (31.75%) individuals were melanistic. Based on the hypothesis of thermal melanism in other species of snakes (*N. natrix*), the high rate of predation, as well as the benefits of climatic conditions, must be investigated (Bury et al. 2022). Additional observations might shed light on this interesting type of choice or the lack of it. Other factors need to be considered, such as age, sex, size and health of the animal, as well as possible effects from being gravid or digesting a meal.

Adders are typically solitary and social interactions are mostly observed between adult snakes and are limited to a short annual mating season (Nilson 1980; Otte et al. 2020). Adders hibernate individually or in small groups, infrequently basking together after emerging from the hibernaculum (Viitanen 1967; Phelps 2004; Dyugmedzhiev et al. 2019). Group basking and refugia sharing, apart from the above-mentioned situations, are only occasionally mentioned in scientific literature (Bauwens and Claus 2021).

## Conclusions

Our observations indicate that there is more that needs to be discovered about inter- and intraspecific communal basking. Interspecific sharing of microhabitats/basking spots by squamate reptiles are rarely described in scientific literature and even less often in Polish language publications (Juszczak 1974; Bauwens and Claus 2021). However, future studies should include additional records of this kind of behaviour that could help determine why there is no sharing of micro-habitats in other potentially-suitable localities. Supplementary data on body and microhabitat temperatures, substrate composition and type (Meek and Luiselli 2022b), habitat complexity and microhabitat characteristics, as well as local meteorological conditions, may be necessary to understand communal basking. More comprehensive research on specific populations sharing microhabitats opens up the possibility of studying in-depth different types of behaviour in the context of thermoregulation. Previous studies on reptiles show direct competition or interference in lizards and turtles (Cady and Joly 2003; Žagar et al. 2015; Hamilton 2021). However, so far there is a noticeable lack of such observations in snakes (Bauwens and Claus 2021) with the exception of garter snakes, *Thamnophis* spp. (Edgehouse et al. 2014). Here,

we present data to aid in alleviating this lack of understanding of the relationship between animals in the context of habitat; this can significantly help in many cases, such as habitat management of protected species.

## Acknowledgements

We thank Dawid Oruba for sharing his remarks and observations and Roger Meek, Apostolos Christopoulos, Yurii Kornilev, Mike Skinner and an anonymous reviewer for helpful suggestions that improved this manuscript. Many thanks to Aleksandra Kolanek for making the map, which exceeded our expectations. Special thanks to Paul Freed.

## References

- Ajtić R, Tomović L, Sterijovski B, Crnobrnja-Isailović J, Djordjević S, Djurakic MR, Golubović A, Simovic A, Arsovski D, Andjelković M, Krstić M, Šukalo G, Gvozdenovic S, Aïdam A, Michel CL, Ballouard J, Bonnet X (2013) Unexpected life history traits in a very dense population of dice snakes. *Zoologischer Anzeiger* 252: 350–358. <https://doi.org/10.1016/j.jcz.2012.10.001>
- Bartman JF, Kudla N, Bradke DR, Otieno S, Moore JA (2016) Work smarter, not harder: comparison of visual and trap survey methods for the eastern massasauga rattlesnake. *Herpetological Conservation and Biology* 11: 451–458.
- Bauwens D, Claus K (2021) Basking aggregations in the adder (*Vipera berus*): attraction to conspecific cues or to scarce suitable microhabitats? *Journal of Ethology* 39: 249–257. <https://doi.org/10.1007/s10164-021-00699-x>
- Boback SM, Nafus MG, Yackel Adams AA, Reed RN (2020) Use of visual surveys and radiotelemetry reveals sources of detection bias for a cryptic snake at low densities. *Ecosphere* 11(1): e03000. <https://doi.org/10.1002/ecs2.3000>
- Bulté G, Blouin-Demers G (2010) Estimating the energetic significance of basking behaviour in a temperate-zone turtle. *Ecoscience* 17: 387–393. <https://doi.org/10.2980/17-4-3377>
- Bury S, Kolanek A, Chylarecki P, Najbar B, Kurek K, Mazgajski TD (2022) Climatic conditions and prevalence of melanistic snakes-contrasting effects of warm springs and mild winters. *International Journal of Biometeorology* 66(7): 1329–1338. <https://doi.org/10.1007/s00484-022-02279-1>
- Cady A, Joly P (2003) Competition for basking places between the endangered European pond turtle (*Emys orbicularis galloitalica*) and the introduced red-eared slider (*Trachemys scripta elegans*). *Canadian Journal of Zoology* 81(8): 1392–1398. <https://doi.org/10.1139/z03-108>
- Chapple DG (2003) Ecology, life-history, and behavior in the Australian scincid genus *Egernia*, with comments on the evolution of complex sociality in lizards. *Herpetological Monographs* 17: 145–180. [https://doi.org/10.1655/0733-1347\(2003\)017\[0145:ELABIT\]2.0.CO;2](https://doi.org/10.1655/0733-1347(2003)017[0145:ELABIT]2.0.CO;2)
- Christopoulos A, Theofanopoulos T, Stavrogiannis L, Droukas G, Kontokostas S, Christopoulos I (2022) Contribution on the distribution of *Eryx jaculus* Linnaeus, 1758 (Squamata: Boidae) in central Greece, with notes on their habitat attributes. *Parnassiana Archives* 10: 11–17.



- Clark RW, Brown WS, Stechert R, Greene HW (2012) Cryptic sociality in rattlesnakes (*Crotalus horridus*) detected by kinship analysis. *Biology Letters* 8: 523–525. <https://doi.org/10.1098/rsbl.2011.1217>
- Costanzo JP (1986) Influences of hibernaculum microenvironment on the winter life history of the garter snake (*Thamnophis sirtalis*). *The Ohio Journal of Science* 86: 199–204.
- Čeirāns A, Nikolajeva L (2017) Habitat ecology of the smooth snake *Coronella austriaca* and its reptilian prey in the degraded bog with implications for artificial refuge surveys. *Zoology and ecology* 27: 19–29. <https://doi.org/10.1080/21658005.2016.1252125>
- Di Nicola MR, Zecchin L, D'Amico M, Faraone FP (2020) Ophiophagy in *Coronella austriaca*: first case of predation on *Hierophis viridiflavus* and first direct observations of predation on *Vipera aspis*. *Herpetology Notes* 13: 1107–1110.
- Doody JS, Dinets V, Burghardt GM (2021) The secret social lives of reptiles. Johns Hopkins University Press, Baltimore, 400 pp. <https://doi.org/10.1353/book.84105>
- Dyugmedzhiev A, Slavchev M, Naumov B (2019) Emergence and dispersal of snakes after syntopic hibernation. *Herpetozoa* 32: 149–157. <https://doi.org/10.3897/herpetozoa.32.e37347>
- Edgehouse M, Latta LC IV, Brodie ED III, Brodie Jr ED (2014) Interspecific Aggression and Habitat Partitioning in Garter Snakes. *PLoS ONE* 9(1): e86208. <https://doi.org/10.1371/journal.pone.0086208>
- Gardner MG, Pearson SK, Johnston GR, Schwarz MP (2015) Group living in squamate reptiles: a review of evidence for stable aggregations. *Biological Reviews* 91: 925–936. <https://doi.org/10.1111/brev.12201>
- Graves BM, Duvall D (1995) Aggregation of squamate reptiles associated with gestation, oviposition, and parturition. *Herpetological Monographs* 9: 102–119. <https://doi.org/10.2307/1466999>
- Hamilton R (2021) Aggressive interactions between a sand lizard *Lacerta agilis* and a common wall lizard *Podarcis muralis* in England. *The Herpetological Bulletin* 155: 28–29. <https://doi.org/10.33256/hb155.2829>
- Juszczyk W (1974) *Plazy i gady krajowe*. Państwowe Wydawnictwo Naukowe, Warszawa, 721 pp.
- Kearney M, Shine R, Comber S, Pearson D (2001) Why do geckos group? An analysis of “social” aggregations in two species of Australian lizards. *Herpetologica* 57: 411–422.
- Kolanek A, Pastrykiewicz M, Borawski W, Bury S (2020) *Coronella austriaca* (smooth snake) - mortality after prey ingestion. *The Herpetological Bulletin* 152: 32–33. <https://doi.org/10.33256/152.3233>
- Luiselli L (1996) Individual success in mating balls of the grass snake, *Natrix natrix*: size is important. *Journal of Zoology* 239: 731–740. <https://doi.org/10.1111/j.1469-7998.1996.tb05474.x>
- Mebert K (2011) The Dice Snake, *Natrix tessellata*: Biology, Distribution and Conservation of a Palearctic Species. *Mertensiella* 18, DGHT Rheinbach, Germany, 456 pp.
- Meek R (2014) Reptile dispersal from a hibernaculum in an agricultural landscape in Western France. *The Herpetological Bulletin* 127: 17–21.
- Meek R, Luiselli L (2022a) Juveniles are different: substrate selection in juvenile green lizards *Lacerta bilineata*. *Ethology Ecology & Evolution*. <https://doi.org/10.1080/03949370.2022.2157893>
- Meek R, Luiselli L (2022b) Living in patchy habitats: substrate selection by basking sympatric lizards in contrasted anthropogenic habitats in western France. *Russian Journal of Herpetology* 29: 227–236. <https://doi.org/10.21203/rs.3.rs-300197/v1>
- Meister B, Ursenbacher S, Baur B (2012) Frequency of multiple paternity in the grass snake (*Natrix natrix*). *Amphibia-Reptilia* 33(2): 308–312. <https://doi.org/10.1163/156853812X634053>
- Mouton PLFN (2011) Aggregation behaviour of lizards in the arid western regions of South Africa. *African Journal of Herpetology* 60: 155–170. <https://doi.org/10.1080/21564574.2011.562926>
- Nilson G (1980) Male reproductive cycle of the European adder, *Vipera berus*, and its relation to annual activity periods. *Copeia* 1980(4): 729–737. <https://doi.org/10.2307/1444451>
- Otte N, Bohle D, Thiesmeier B (2020) *Die Kreuzotter, ein Leben in ziemlich festen Bahnen*. Laurenti, Bielefeld, 256 pp.
- Phelps T (2004) Population dynamics and spatial distribution of the adder *Vipera berus* in southern Dorset, England. *Mertensiella* 15: 241–258
- Rabosky ARD, Corl A, Liwanag HEM, Surget-Groba Y, Sinervo B (2012) Direct Fitness Correlates and Thermal Consequences of Facultative Aggregation in a Desert Lizard. *PLoS ONE* 7(7): e40866. <https://doi.org/10.1371/journal.pone.0040866>
- Regnet RA, Quintela FM, Entiauspe-Neto OM, Teixeira VHS, Silva FL, Loebmann D (2017) Remarkable aggregation of squamates and caecilians associated with flood events during El Niño in southern Brazil. *Salamandra* 53: 537–540.
- Seebacher F, Franklin CE (2005) Physiological mechanisms of thermoregulation in reptiles: a review. *Journal of Comparative Physiology B* 175: 533–541. <https://doi.org/10.1007/s00360-005-0007-1>
- Shah B, Hudson S, Shine R (2006) Social aggregation by thick-tailed geckos (*Nephurus milii*, Gekkonidae): does scat piling play a role? *Australian Journal of Zoology* 54: 271–275. <https://doi.org/10.1071/ZO06012>
- Turner GS (2022) Thermal benefits of clumping aggregations in captive blue-tongued lizards. *The Victorian Naturalist* 139(3): 64–69. <https://search.informit.org/doi/10.3316/informit.535990383649699>
- Vasconcelos R, Rocha S, Santos X. (2017) Sharing refuges on arid islands: ecological and social influence on aggregation behaviour of wall geckos. *PeerJ* 5: e2802. <https://doi.org/10.7717/peerj.2802>
- Viitanen P (1967) Hibernation and seasonal movements of the viper, *Vipera berus* (L.), in southern Finland. *Annales Zoologici Fennici* 4: 472–546.
- Žagar A, Carretero MA, Osojnik N, Sillero N, Vrezec A (2015) A place in the sun: interspecific interference affects thermoregulation in coexisting lizards. *Behavioral Ecology and Sociobiology* 69: 1127–1137. <https://doi.org/10.1007/s00265-015-1927-8>